

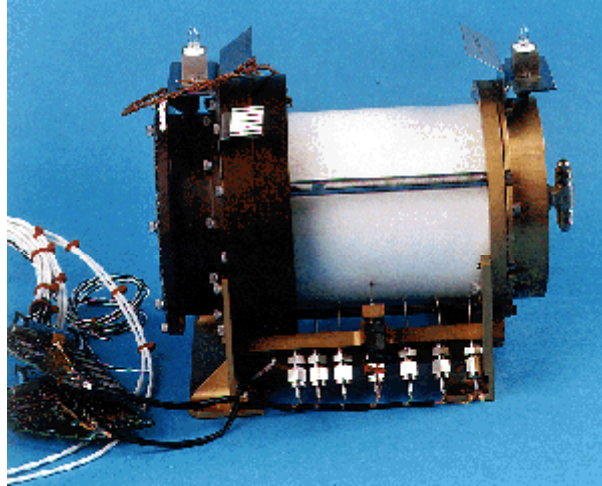
Microgravity Smoldering Combustion Takes Flight

The Microgravity Smoldering Combustion (MSC) experiment lifted off aboard the Space Shuttle Endeavour in September 1995 on the STS-69 mission. This experiment is part of a series of studies focused on the smolder characteristics of porous, combustible materials in a microgravity environment. Smoldering is a nonflaming form of combustion that takes place in the interior of combustible materials. Common examples of smoldering are nonflaming embers, charcoal briquettes, and cigarettes.

The objective of the study is to provide a better understanding of the controlling mechanisms of smoldering, both in microgravity and Earth gravity. As with other forms of combustion, gravity affects the availability of air and the transport of heat, and therefore, the rate of combustion. Results of the microgravity experiments will be compared with identical experiments carried out in Earth's gravity. They also will be used to verify present theories of smoldering combustion and will provide new insights into the process of smoldering combustion, enhancing our fundamental understanding of this frequently encountered combustion process and guiding improvement in fire safety practices.

In the Microgravity Smoldering Combustion experiment during STS-69, two tests were conducted to investigate the spread of smolder along a sample of polyurethane foam (120-mm diameter by 140-mm long) under two experimental conditions: (1) in a still environment of 35 percent oxygen/65 percent nitrogen and (2) in an opposing air flow (1-mm/sec flowing through the foam in the direction opposite to that of the smolder propagation). Each combustion test was conducted in a 20-liter sealed chamber that was instrumented to obtain pressure, temperature, and video data. The flight data have been obtained and are being analyzed by the principal investigator.

Polyurethane foam was selected as the fuel sample because it is representative of materials commonly used on Earth and in space-based facilities. The environmental conditions are part of a matrix of planned experiments in a nonconvective environment with oxygen concentrations higher than in air and in a convective environment with velocities similar to those that can be expected from the ventilating system in space facilities.



Microgravity Smoldering Combustion fuel sample and test section assembly.

The experiment was conceived by Professor A. Carlos Fernandez-Pello at the University of California at Berkeley. The hardware, which was designed and built at the NASA Lewis Research Center by a mixed team of civil servants and contractors from NYMA and Aerospace Design & Fabrication, Inc. (ADF), consists of two sealed aluminum combustion chambers (each one a half cylinder), data acquisition electronics, power distribution electronics, and instrumentation. The hardware is contained a 5-ft³ Get-Away Special (GAS) canister and flown in the shuttle cargo bay. The chambers hold the MSC test section (fuel sample) and its temperature and pressure instrumentation. The test section (shown in the figure) consists of a quartz cylinder that contains the polyurethane foam sample and an igniter. This igniter, which is an electrically heated wire sandwiched between two porous ceramic disks, is mounted in contact with the end of the foam sample. An array of 12 thermocouples placed axially and radially along the foam sample provides temperature histories, which are used to determine the rate of smolder propagation and the characteristics of the reaction.